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# COMPARISON OF A DRAINAGE FLOW MODEL WITH THE DATA OF MANINS & SAWFORD

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## 1. INTRODUCTION

Our drainage flow model is based on an adaptation of the 1D boundary layer code, SIGMET (Freeman et al.-(1976)), in a mannner proposed by Brost and Wyngaard (1978). We assume a surface of large sloping area with a constant thickness boundary layer having an initial surface temperature at 6 PM of 293 K. The latitude in Australia, where the experiment was performed (Jeeraling Hills), is approximately 38 degrees south. We assume an initial relative humidity of 30% with the surface having a slope of 4.5 degrees to the horizontal.

## 2. THEORETICAL APPROACH

SIGMET is a system of computer codes developed to simulate mesoscale meteorology in regions containing complex terrain. The codes have been applied to problems of wind energy device siting in complex terrain and to flow over roughness interfaces, among other applications. The detailed physics of radiation transport and turbulence are treated the same way for the 1-, 2-, and 3-dimensional versions of the code. The horizontal advection and diffusion are treated in constant zone x-y geometry. In the vertical direction the primitive equations are written in sigma coordinates and a second order turbulence model, which includes the production, dissipation and diffusion of turbulent kinetic energy, is employed. Bouyancy terms enter the equations through a generalized Richardson number containing both temperature and water vapor gradients. The effects of the stability of the atmosphere are incorporated into this number. Diffusion coefficients for kinetic energy and momentum are evaluated in terms of the turbulent kinetic energy. We consider an idealized surface of constant slope and study the forcing mechanism, the friction forces, and the diurnal variations of these parameters. The phenomenon of nocturnal winds developing in valleys or along mountain slopes is well known. The forcing mechanism is temperature differences along the valley slopes that create a pressure gradient in an up-slope direction in the day and down-slope at night. However, the effects of vegetation, humidity, large scale geostrophic winds, etc., on the local drainage flow have not been thoroughly investigated. The ASCOT program requires a more quantitative investigation of these parameters as well as the 2- and 3- dimensional effects imposed by the terrain. Our study attempts to quantify some of these idealized physical effects, assuming that it is possible to separate out the geometry effects in the measurements. Buoyancy terms of slope flow have been added to the momentum equations of 1D SIGMET in a manner described by Brost and Wyngaard; while an advection term has been added to the temperature equation following Prandtl (Davis and Freeman (1981)).

## 3. INITIALIZATION

In order to obtain the near surface velocities, as observed, we adjust the roughness parameter ($Z_o$). Our value of 10 cm is in general agreement with that proposed by the observers of 2 cm with the statement that it could be larger. The temperature lapse rate in the air above the drainage flow layer is assumed to be 5 K/km, again in general agreement with Manins and Sawford (1979).

## 4. RESULTS

The calculation is started at 6 PM with a surface temperature of ~293 K, a relative humidity of 30%, and zero ambient winds. The temperature evolves as shown in Fig. 1 where the transport of radiation through a cloudless sky is treated in a manner proposed by KATAYAMA (1974). We compare our results in Fig. 2 to Manins & Sawford's (Fig. 6) the second day and find our $U_{max}$ (3.4 m/s) in good agreement with the observations. The height where $U_{max}$ occurs also appears to be near that observed (~20 meters). These results imply that the observed synoptic winds (2-3 m/s), generally in a direction opposed to the drainage flow, had little effect on the magnitude or height of the developed nocturnal slope flow over simple terrain.

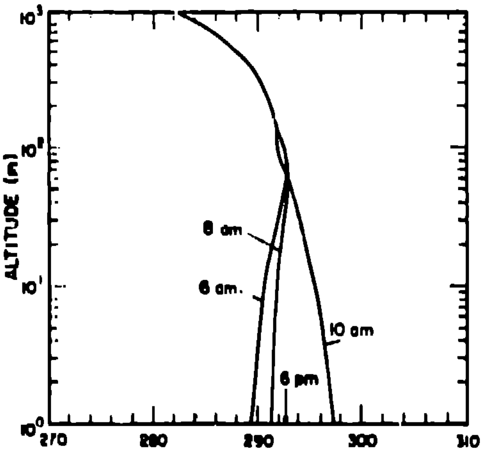


Fig 1. The evolved temperature vs altitude at selected times. The surface temperature for an initialized adiabatic lapse rate $\gamma$=0.01 K/m is shown at 6 PM.

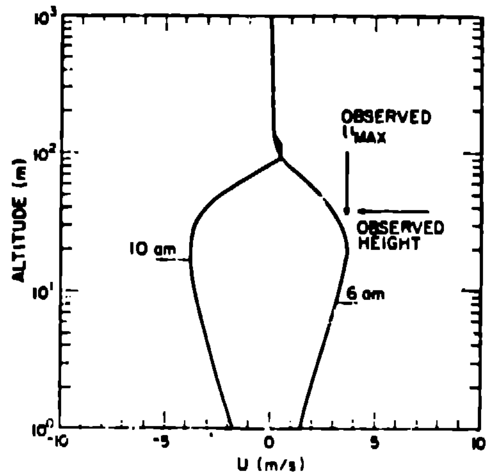


Fig. [illegible] The evolved velocity profiles vs altitude for the Manins & Sawford experimental slope [illegible]. The observations are for 6:00 AM on the [illegible]nd day.

5. References

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